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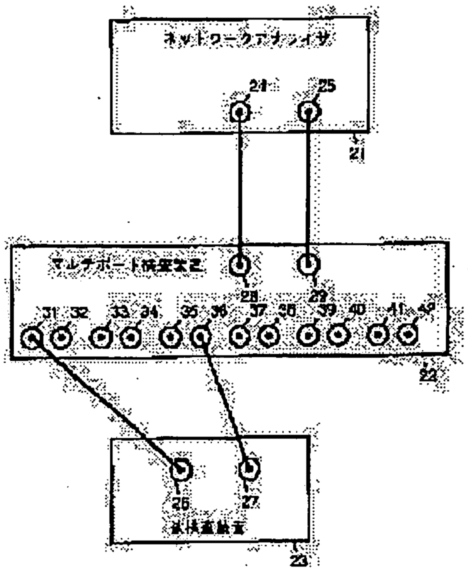
(54) AUTOMATIC CALIBRATION OF NETWORK ANALYZER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for calibrating a network analyzer system, the method enabling complete transfer calibration of a multiport inspection device without requiring a long time.
SOLUTION: A radio frequency network analyzer system 21 connected to a multiport inspection device 22 is calibrated. Initial calibration is effected at every inspection device port in the multiport inspection device 22. The initial calibration is performed by first executing measurement calibration by use of a calibration reference. The calibration reference is located within a reference plane placed outside the multiport inspection device 22. An initial calibration coefficient can be obtained by the measurement calibration. The initial calibration also includes generating an initial measurement electron reference by measuring electron references 73-77, 80, 83 in the multiport inspection device 22. An initial correction electron reference is generated by use of the initial calibration coefficient and the initial measurement electron reference.



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CLAIMS

[Claim(s)]
[Claim 1] It is an approach for proofreading a network analyzer system (21 22). (a) It is the initial proofreading step which carries out initial proofreading of each inspection port (24, 25, 31-42) of a network analyzer system (21 22). Carry out measurement proofreading using the proofreading criteria located in the base plane arranged to the exterior of a network analyzer system (21 22), and an initial proofreading multiplier is generated. (a. 1) Measure the electronic criteria (80 73-77, 83) in a network analyzer system (21 22), and initial measurement electronic criteria are generated. (a. 2) The initial proofreading step containing each substep of generating initial amendment electronic criteria using said initial proofreading multiplier and said measurement electronic criteria, (a. 3) (b) Are the automatic recalibration step which carries out automatic recalibration, and measure the electronic criteria (80 73-77, 83) in a network analyzer (b. 1) system (21 22), and recalibration measurement electronic criteria are generated. (b. 2) The proofreading approach of the network analyzer system characterized by having an automatic recalibration step containing each substep of generating a re-calculation proofreading multiplier using these recalibration measurement electronic criteria and said initial amendment electronic criteria.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to automatic proofreading of a network analyzer about a radio frequency and a microwave network analyzer.
[0002]
[Description of the Prior Art] It consists of network analyzers and multiport test equipment can be included by the (radio frequency RF) network analyzer system. A network analyzer unites a synthetic radio frequency generation source with the inclusion coupler for signal separation, a narrow-band receiver, a display, and a processor.

[0003] Measurement proofreading is a process which raises measurement forward precision by compensating a systematic measurement error during signal processing using an error correction array. Measurement proofreading is also called Cal, the improvement in precision, and error correction. A measurement error is classified into a random error and a systematic error. The random error of the repeatability of a noise and a connector does not have repeatability, and measurement proofreading cannot amend it.

[0004] Systematic errors, such as tracking and a cross talk, are most important errors in a great portion of RF measurement. A systematic error has repeatability, and although it is possible to amend almost all the parts, few residua may remain. The drift of these systematic errors can be carried out according to time amount and temperature.

[0005] A systematic error originates in the frequency response of a system, the separation between signal paths, and the mismatching in test equipment. A frequency-response error (transmission and reflective tracking) is a gain error it is without error in the function of a frequency.

[0006] A separation error is produced by energy leakage between the signal paths in transmission measuring. This leakage is based on a cross talk. Moreover, in reflective measurement, this leakage is based on imperfect directivity. Directivity is the capacity of the signal decollator into which the signal which advances to the forward direction is made to separate from the signal which advances to hard flow.

[0007] A mismatching error is produced from the difference of the port impedance of inspected equipment (DUT), and the port impedance of a network analyzer. A source adjustment error is produced in the source side (RF OUT side of a network analyzer) of DUT, and a load adjustment error is produced in a load side (RF IN side of a network analyzer). When direct continuation of DUT is not carried out to a port, the mismatching error resulting from a cable, an adapter, etc. can be considered to be a part of source adjustment error or load adjustment error.

[0008] The network analyzer has some approaches for measuring and compensating these check system errors. An all directions method removes one or two systematic errors or more using the equation called a disturbance model. By performing measurement (for example, through [a short circuit, disconnection, a load, and through]) by high quality criteria, it becomes possible to undo a network analyzer about the error term in a disturbance model. The precision of the proofread measured value is decided by the quality of the criteria used, and the stability of a gaging system. Since the criteria of proofreading are very precise, an outstanding precision can be acquired.

[0009] In order to carry out transmission proofreading, four metrics (standard), for example, disconnection, a short circuit, a load, and a through cable are used. A network analyzer measures about each criteria over a predetermined frequency band using a number of points determined beforehand. The measurement about these criteria is used in order to calculate a solution about the error term in a disturbance model, and in order to remove the systematic error produced by the frequency response and source adjustment.

[0010] Moreover, in order to carry out reflective proofreading, 1 port proofreading is carried out using three metrics, i.e., disconnection, a short circuit, and a load. A network analyzer measures about each criteria over a predetermined frequency band using a number of points determined beforehand. The measurement about these criteria is used in order to calculate a solution about the error term in a disturbance model, and in order to remove directivity, source adjustment, and the systematic error produced by the frequency response.

[0011] Please refer to available "available H.P. 8712C and HP8714 C RF Network Analyzer User's Guide" (Part No.08712-90056, October1996, pp 6-1 to 6-14) from Hewlett Packard about the further information about proofreading of a network analyzer, for example.

[0012] By switching test equipment, it becomes possible for it to become possible about the measurement capacity of a network analyzer to make a single pair extend to many ports from the port to make, and to perform measurement of the forward direction and hard flow to inspected equipment. Test equipment increases a throughput sharply by eliminating modification by the hand control of connection of equipment, and enabling perfect automation of an inspection process, when inspecting equipment using a network analyzer.

[0013] However, if test equipment is added after a network analyzer, the engine performance of network analyzer system original may be degraded sharply. Furthermore, the drift of the property of test equipment is carried out according to temperature. Although, as for vector error correction, a system (it consists of a network analyzer and test equipment) makes it possible to attain the extremely excellent engine performance, frequent recalibration is needed for the drift of test equipment. With some equipment, implementation of multiport proofreading may take the time amount exceeding 30 minutes, and it is the shift in every 8 hours, and it may be necessary to repeat said operation frequently. For this reason, the improvement of the throughput offered with switching test equipment will be reduced sharply.

[0014] In order to shorten time amount required for proofreading, a certain automation device is included in various systems. For example, to U.S. Pat. No. 5,434,511, No. 5,467,021, No. 5,537,046, No. 5,548,221, and No. 5,578,932, the proofreading with the computer exchange using electronic criteria is carried out, and it indicates the proofreading process about the electronic proofreading accessory which makes time amount more ****** and the thing which an error does not generate more. However, in using these electronic proofreading accessory, it is necessary to connect a module to a measurement port manually. The electronic proofreading module which needs manual connection also for U.S. Pat. No. 5,587,934 is indicated.

[0015] The technique for taking in electronic proofreading is shown in multiport test equipment at U.S. Pat. No. 5,578,932. However, it is thought that this technique uses the electronic criteria of a highly precise property. At present, this takes into consideration the proofreading in locations other than the port on the front panel of a network analyzer.

[0016] Technique including the proofreading inside a network analyzer is indicated by U.S. Pat. No. 5,548,538. This technique needs to add 2 port module of a highly precise property for the front face of a test equipment port. The error matrix about this 2 port module to the known criteria in the port of test equipment is searched for. Subsequently, the reflection coefficient of the electronic proofreading criteria in 2 port module can be calculated by the ability to use this error matrix, and the automatic proofreading after it can be enabled.

[0017]

[Problem(s) to be Solved by the Invention] However, as for time amount, all of the technique of these existing still start extremely, when it applies to multiport test equipment, and when using for perfect transmission proofreading of multiport test equipment, it will become very complicated.

[0018]

[Means for Solving the Problem] According to the desirable embodiment of this invention, a network analyzer system is proofread. For example, the radio frequency network analyzer or the microwave network analyzer is contained in the network analyzer system. Initial proofreading is carried out for each [in a network analyzer system] inspection port of every. This initial proofreading is performed by carrying out measurement proofreading first using proofreading criteria. These proofreading criteria are arranged in the base plane arranged to the exterior of a network analyzer system. An initial proofreading multiplier is obtained by this measurement proofreading. Measuring the electronic criteria in a network analyzer system, and generating initial measurement electronic criteria is also included in this initial proofreading. Initial amendment electronic criteria are generated using this initial proofreading multiplier and initial measurement electronic criteria.

[0019] Automatic recalibration is periodically carried out after this initial proofreading. At the time of operation of this automatic recalibration, the electronic criteria in a network analyzer system are measured, and recalibration measurement electronic criteria are generated. A re-calculation proofreading multiplier is obtained using these recalibration measurement electronic criteria and said initial amendment electronic criteria.

[0020] Disconnection, a short circuit, and a load are contained in electronic criteria in the desirable embodiment. Here, "disconnection" means the circuit which approximates an open circuit, a "short circuit" means the circuit which approximates a short circuit, and the "load" means the circuit where a reflection coefficient approximates the circuit of zero. Three reflection error multipliers (DIR), i.e., directivity, source adjustment (SM), and reflective tracking (RT) are included in the initial proofreading multiplier. Moreover, one transmission error coefficient (TT), i.e., transmission tracking, is contained in this initial proofreading multiplier.

[0021] This invention functions good, also when the network analyzer system is equipped with the multiport test equipment connected to the network analyzer again. In this case, the inspection port of a network analyzer system is a test equipment port of multiport test equipment, and electronic criteria are held in multiport test equipment.

[0022] Moreover, in the desirable embodiment, in case measurement proofreading is carried out during initial proofreading, measured value (R_RAW) of reflective proofreading criteria is related with the correction value (R_COR) of reflective proofreading criteria according to the error model equation shown below.

[0023]

[Equation 1]

$$R\_RAW = DIR + \frac{R\_COR \times RT}{1-(SM \times R\_COR)}.$$

[0024] In case measurement proofreading is carried out during initial proofreading, measured value (T_RAW) of transmission proofreading criteria is related with the correction value (T_COR) of transmission proofreading criteria again according to the error model equation shown below.

[0025]

[Equation 2]

$$T\_COR = \frac{T\_RAW}{TT \times (1 - SM \times R\_COR)}$$

[0026] In the desirable embodiment, a test equipment port is divided so that a pair may be made. In case measurement proofreading is carried out in initial proofreading, the 1st ratio of the transmission response of a fastener and a cable and a proofreading through transmission response of the port which makes a pair is called for. This proofreading through transmission response is calculated by connecting each set of a test equipment port electrically using a proofreading through line. Moreover, the transmission response of a fastener and a cable is calculated by connecting each set of a test equipment port electrically mutually using a fastener and a cable. For example, a proofreading through line is switched electronically and a fastener and a cable are physically connected in a base plane.

[0027] When the 2nd test equipment port makes the 3rd test equipment port and a pair and it calculates the transmission response error coefficient between the 1st test equipment port and the 2nd test equipment port, the transmission response of the internal proofreading through path transmission value between the 3rd test equipment port and the 2nd test equipment port is measured. The multiplication of the 1st ratio and 2nd ratio is carried out to the internal transmission response of a proofreading through path transmission value between the 3rd test equipment port and the 2nd test equipment port. The 1st ratio is calculated as mentioned above. Moreover, the 2nd ratio is a ratio of the transmission response between the reflective input of multiport test equipment, and the 1st port, and the transmission response between the reflective input of multiport test equipment, and the 3rd port.

[0028] Moreover, multiport test equipment is equipped with a reflective input, a transmission output, two or more test equipment ports, two or more port lines, the 1st switching means, the 2nd switching means, and two or more interfaces in the desirable embodiment. A reflective input is for connecting with a network analyzer. A transmission output is for connecting with a network analyzer. Each port line relates to one test equipment port in two or more test equipment ports. The 1st switching means connects a reflective input to one of two or more port lines. The 2nd switching means connects a transmission output to one of two or more port lines. Each interface relates to one test equipment port in two or more test equipment ports. The 1st interface is equipped with test equipment Rhine to two or more electronic criteria and the 1st test equipment port relevant to the 1st interface, and a selection means. This selection means chooses test equipment Rhine which should choose one electronic criteria in two or more electronic criteria, or should be connected to the 1st port line from two or more port lines. The 1st port line relates to the 1st test equipment port. One of electronic criteria is equipped with the through transmission line to the 2nd interface of two or more interfaces. This 2nd interface relates to the 2nd test equipment port of two or more test equipment ports. this — the 2nd test equipment port is making the 1st test equipment port and a pair.

[0029] This invention enables the completely automatic proofreading based on the initial proofreading in one flat surface chosen by the user. Furthermore, this invention simplifies multiport transmission proofreading and makes it possible to carry out this multiport transmission proofreading, without needing to make "through" connection among [no] test equipment ports.

[0030]

[Embodiment of the Invention] Drawing 1 is the block diagram simplifying and showing the network analyzer system connected to inspected equipment (DUT) 23. This radio frequency network analyzer system is equipped with the network analyzer 21 connected to multiport test equipment 22. This network analyzer 21 is for example, a radio frequency network analyzer or a microwave network analyzer. This radio frequency network analyzer system is connected to inspected equipment (DUT) 23 using the test equipment port of multiport test equipment 22. This DUT23 has the port 26 and the port 27. The network analyzer 21 has the radio frequency (RF) output port 24 and radio frequency (RF) input port 25. In order to inspect, multiport test equipment 22 connects the reflective port 28 to one of the test equipment ports 31, 32, 33, 34, 35, 36, 37, 38, 38, 39, 40, 41, and 42. Similarly, in order to inspect, multiport test equipment 22 connects the transmission port 29 to one of the another side of the test equipment ports 31, 32, 33, 34, 35, 36, 37, 38, 38, 39, 40, 41, and 42. Although multiport test equipment 22 has the test equipment port of 12 like illustration, it can also have the test equipment ports (for example, four pieces, six pieces, eight etc. pieces, etc.) of the other number.

[0031] Drawing 2 is the block diagram simplifying and showing the radio frequency network analyzer 21 by the conventional technique. The radio frequency generation source 51 sends out a radio frequency output signal to the RF output port 24. This radio frequency output signal is connected also to reference signal Rhine 52 and the reflective signal line 53. An analog-to-digital converter (ADC) 58 is connected to a mixer 54, a mixer 56, and a mixer 55. This mixer 55 is connected to the reflective signal line 53.

[0032] The signal received by the analog-to-digital converter 58 is changed into a digital signal, and is sent to a signal processor 59. This signal processor 59 processes this signal, and displays data on a display 60. A signal processor 59 amends measurement data in the middle of processing of a signal using the error correction array data calculated during proofreading.

[0033] Drawing 3 is the explanatory view showing some multiport test equipment 22, and shows the electronic criteria immediately behind the port of multiport test equipment 22. A switch 61 chooses from one of the test equipment ports 31, 32, 33, 34, 35, 36, 37, 38, 38, 39, 40, 41, and 42 the interface which should be connected to the reflective port 28. Rhine 71 used in order to connect to the reflective port 28 the interface of Rhine 69 used for drawing 3 in order to connect the interface of the test equipment port 36 to the reflective port 28, and the test equipment port 35 is shown. Rhine 81 is used in order to connect the interface of other test equipment ports to the reflective port 28. Although only four Rhine is shown, when multiport test equipment 22 is equipped with the test equipment port of 12, in addition to Rhine 69 and 71, ten Rhine exists in fact.

[0034] A switch 62 chooses from one of the test equipment ports 31, 32, 33, 34, 35, 36, 37, 38, 38, 39, 40, 41, and 42 the interface which should be connected to the transmission port 29. Rhine 72 used in order to connect to the transmission port 29 the interface of Rhine 70 used for drawing 3 in order to connect the interface of the test equipment port 36 to the transmission port 29, and the test equipment port 35 is shown. Rhine 82 is used in order to connect the interface of other test equipment ports to the transmission port 29. Although only four Rhine is shown, when multiport test equipment 22 is equipped with the test equipment port of 12, in addition to Rhine 70 and 72, ten Rhine exists in fact.

[0035] A switch 68 chooses to any of Rhine 69 and 70 the interface of the test equipment port 36 is connected. A switch 67 chooses whether an interface is chosen to whether it is chosen to the test equipment port 36, disconnection 76 or a short circuit 75, a load 80, or the proofreading through line 73. Disconnection 76, a short circuit 75, a load 80, and the proofreading through line 73 are used as internal criteria for the electronic proofreading accompanied by the test equipment port 36. Disconnection 76, a short circuit 75, and a load 80 are reflective criteria which make it possible to acquire directivity, source adjustment, and the solution of reflective tracking. The proofreading through line 73 makes it possible to acquire the solution of transmission tracking. A switch 66 chooses whether the test equipment port 36 is made into an active state, or it connects with a load 79.

[0036] A switch 63 chooses to any of Rhine 71 and 72 the interface of the test equipment port 35 is connected. A switch 64 chooses whether it chooses to whether an interface is chosen to the test equipment port 35, disconnection 74 or a short circuit 83, a load 77, or the proofreading through line 73. Disconnection 74, a short circuit 83, a load 77, and the proofreading through line 73 are used as internal criteria for the electronic proofreading accompanied by the test equipment port 35. Disconnection 74, a short circuit 83, and a load 77 are reflective criteria which make it possible to acquire directivity, source adjustment, and the solution of reflective tracking. The proofreading through line 73 makes it possible to acquire the solution of transmission tracking. A switch 65 chooses whether the test equipment port 35 is made into an active state, or it connects with a load

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[0037] Multiport test equipment 22 enables electronic proofreading. In reflective measurement, 1 port proofreading is used. In order to search for a reflection error multiplier (DIR), i.e., directivity, source adjustment (SM), and reflective tracking (RT), measurement of three proofreading criteria is needed. According to the following several 3, since measurement data is expressed about actual data (R_COR), these three multipliers are used.

[0038]

[Equation 3]

$$R\_RAW = DIR + \frac{R\_COR \times RT}{1-(SM \times R\_COR)}$$

[0039] this — in order to calculate a solution about three multipliers, measurement of three known amounts is performed. These three known amounts can be considered as the amount of arbitration. Disconnection, a short circuit, and a load are used in the desirable embodiment. Disconnection means the circuit which approximated the open circuit, a short circuit means the circuit which approximated the short circuit, and the load means the circuit where the reflection coefficient approximated the circuit of zero.

[0040] Therefore, disconnection, the short circuit, and the circuit that approximated the load are included in the interface of each test equipment port. For example, in the case of the test equipment port 36, a load 80 is used for a load for a short circuit of a short circuit 75 for disconnection of disconnection 76. For example, in the case of the test equipment port 35, a load 77 is used for a load for a short circuit of a short circuit 83 for disconnection of disconnection 74. Disconnection, the short circuit, and the load were used in order to make operation of a circuit easy, but as long as each presents a fully different impedance, they can use three criteria of arbitration other than the above. Please refer to available "H.P.8753 D Network Analyzer User's Guide" (Part No.08753-90257, September, 1995, pp.6-37-6-44) from Hewlett Packard about the further information about generation of a multiplier.

[0041] In the case of transmission measuring, the strengthened response proofreading (source adjustment and amendment of a frequency response) is used. The test equipment port was divided so that a pair might be made, and it is equipped with the proofreading through path in which the switch between these each sets is possible. The transmission route for self calibrating is offered according to this proofreading through path. For example, the proofreading through line 73 functions as a proofreading through path for the pair which consists of a test equipment port 35 and a test equipment port 36.

[0042] When calculating the actual data (T_COR) about transmission, the transmission tracking (TT) which is the source adjustment (SM) and the transmission error coefficient which are a reflection error multiplier is used, and actual tracking (measurement) data (T_RAW) are corrected according to the following several 4.

[0043]

[Equation 4]

$$T\_COR = \frac{T\_RAW}{TT \times (1 - SM \times R\_COR)}$$

[0044] Since the source adjustment (SM) which is a reflection error multiplier is calculated in case it solves several 3, in quest of a solution, only one measured value is needed about the transmission tracking (TT) which is one transmission error coefficient.

[0045] In the case of a desirable embodiment, initial proofreading is carried out before implementation of automatic proofreading. The 1st part of initial proofreading carries out measurement proofreading about 1 set of known criteria. In order to generate the value about three reflection error multipliers and one transmission error coefficient, three reflective measurement and one transmission measuring are carried out. Measurement proofreading can be carried out in the base plane of arbitration in the connector type of the arbitration which can offer a proofreading kit definition (calibration kit definition). Generally, in measurement proofreading, the proofreading criteria which proofreading criteria are arranged between multiport test equipment 22 and DUT23, and are in the flat surface near DUT23 as much as possible are used. As mentioned above, the value about the directivity (DIR) which is a reflection error multiplier, source adjustment (SM) and reflective tracking (RT), and the transmission tracking (TT) that is a transmission error coefficient is acquired by measurement proofreading.

[0046] The electronic criteria inside test equipment (namely, through [disconnection, a short circuit, a load, and through]) are measured, and the correction term (R_COR and T_COR) acquired as the result uses the multiplier by measurement proofreading, and is calculated about each of electronic criteria. Since inner electron criteria (in namely, the in disconnection, a short circuit, and the case of a load) are behind a proofreading base plane, negative electric delay is shown. The criteria (namely, disconnection and a short circuit) that a reflection factor is high may show the magnitude of the reflection coefficient exceeding 1. In reflective measurement, only three reflective criteria (namely, disconnection, a short circuit, and a load) are measured, but value R_COR for every reflective criteria is saved for subsequent automatic proofreading. In the case of transmission measuring, proofreading through is measured and value T_COR obtained as a result is saved. Value R_COR and T_COR which were memorized are used for subsequent automatic proofreading. Electronic criteria are simple, and since they are designed so that it may become what was stabilized extremely, if they are repeated at long spacing of 1 time per month, they are enough. [of initial proofreading (measurement proofreading is included)]

[0047] The drift of the hardware in a network analyzer 21 and multiport test equipment 22 produces the fall of measurement forward precision. Periodically, whenever it uses it for 30 minutes, automatic recalibration is carried out and the precision in early stages of the proofread system is recovered.

[0048] Automatic recalibration is carried out using the initial amendment electronic criteria (R_COR and T_COR) calculated in initial proofreading. When carrying out automatic recalibration, R_RAW is measured about each of three reflective criteria, and the directivity (DIR) which is three reflection error multipliers, source adjustment (SM), and reflective tracking (RT) are re-calculated using storage value R_COR (1 of initial amendment electronic criteria) about each reflective criteria. Moreover, T_RAW is measured and the transmission tracking (TT) which is a transmission error coefficient is re-calculated using storage value T_COR (1 of initial amendment electronic criteria).

[0049] The above automatic recalibration is shown in drawing 4 . At step 91, measurement error amendment disables in a network analyzer 21. Non-amended measurement of electronic proofreading criteria is performed at step 92. In reflective measurement, three reflective criteria are measured. Moreover, in the case of transmission measuring, a proofreading through path is also measured.

[0050] An error coefficient array is calculated from the measured value from which step 93 was obtained at step 92. The calculated error coefficient array offers the amendment measured value of the same internal reference as what is depended on initial proofreading. In addition to initial amendment electronic criteria, the measured value of three reflective criteria enables it to calculate directivity, source adjustment, and the solution of reflective tracking.

[0051] At step 94, the calculated error coefficient is loaded to a network analyzer 21 in preparation for the error correction about consecutive measurement.

[0052] The measured value of the amended internal reference becomes the same as that of what is depended on initial proofreading after automatic recalibration. It becomes possible to remove the measurement drift of all the hardware within a test equipment signal path to the location of the internal reference used for the measurement drift of the reflectiometer in a network analyzer 21, and the proofreading in multiport test equipment 22 by this automatic recalibration. The unremovable sources of a drift within a signal path are only the drift of the internal reference itself, and the cable located behind criteria in the signal path in multiport test equipment 22, a connector and the drift of a fastener.

[0053] So far, proofreading of the radio frequency network analyzer system containing multiport test equipment has been explained. In the case of the network analyzer system which does not contain multiport test equipment, electronic criteria are moved behind the RF output port 24 and RF input port 25 into a network analyzer 21. In this case, above-mentioned initial proofreading and automatic recalibration are carried out using the RF output port 24 and RF input port 25. In this case, the RF output port 24 and RF input port 25 are inspection ports of a network analyzer system.

[0054] It is necessary for the perfect transmission proofreading using the test equipment of 12 ports for the transmission route of 132 which can be considered to usually attach all, and to clarify a property. This proofreading is unsuitable to manufacture of a high throughput because of the time amount which it takes. For this reason, a manufacturer cannot but reduce inspection even to the absolute number of a transmission route. Consequently, although proofreading time amount is shortened, in the case of large-scale multiport equipment, the number of paths becomes with still very many things.

[0055] in order to carry out automatic proofreading about all the paths of 132 which 12 port test equipment can consider — this — the proofreading matrix which can offer the path of the arbitration of the path of 132 is needed. It will be designed so that this matrix may become very complicated and even the switch matrix exceeding 12 ways may make switching test equipment. Thereby, a proofreading matrix will become more unstable than test equipment. For this reason, in the case of the desirable embodiment of this invention, a different approach is used.

[0056] A transmission reply signal path is divided into a detail to six parts. The 1st part of this path is in a network analyzer 21. The 2nd part of this path is from the RF output port 24 of a network analyzer 21 to the reflective port 28. The 3rd part of this path is wiring and the test equipment switch which route a RF signal from the reflective port 28 to the test equipment port 31. The 4th part of this path is custom-made wiring and the fastener from the test equipment port 31 to the test equipment port 36. The 5th part of this path is wiring and the test equipment switch which route a RF signal from the test equipment port 36 to the transmission port 29. The 6th part of this path is a part which returns from the transmission port 29 to the RF input port 25 of a network analyzer 21.

[0057] When carrying out transmission measuring between the test equipment ports of the pair which has a proofreading through path, it is possible to use the proofreading through line for [this] a pair. For example, when carrying out transmission measuring between the test equipment port 35 and the test equipment port 36, a switch 67 connects with the proofreading through line 73, a switch 64 connects with the proofreading through line 73, and, thereby, a proofreading through path is offered.

[0058] When transmission measuring is carried out between the ports (that is, it is not a "pair") which do not have a proofreading through path in between, reflective measurement of the criteria behind [of making a reflective port and a pair] a port, and transmission measuring of the proofreading through path between the ports and transmission ports which make a pair are carried out. Therefore, it is possible to separate a transmission signal path response mathematically, and to carry out automatic proofreading between two ports of arbitration.

[0059] Drawing 5 shows various components of the transmission response about the test equipment port 31 which does not have a proofreading through path in between, and the transmission measuring carried out among 36. A network analyzer transmission response (T_NA) is a transmission response through a network analyzer 21. A reflective port transmission response (T_REFL) is a transmission response in alignment with the path 101 from the reflective port 28 to the test equipment port 31 (reflective port). The transmission response of a fastener and a cable (T_CUST) is a transmission response in alignment with the path 102 between the test equipment port 31 and the test equipment port 36.

[0060] The transmission response (T_PAIR) of the port which makes a pair is a transmission response in alignment with the path 103 from the reflective port 28 to the test equipment port 35 (port which makes a pair). The transmission response (T_TRAN) of a transmission port is a transmission response in alignment with the path 105 from the test equipment port 36 (transmission port) to the transmission port 29. A proofreading through transmission response (T_CALTHRU) is a transmission response in alignment with the path 104 from the test equipment port 35 to the test equipment port 36. A path 10 is electronic through proofreading criteria (called a through line).

[0061] the operative condition of this invention with desirable drawing 6 — it is the flow chart which shows the separation of a transmission signal path response and the implementation of automatic proofreading about two ports without the proofreading through path depended like.

[0062] In step 111, transmission response proofreading is carried out between the port which makes a pair, and a transmission port. Typically, this step is carried out before automatic proofreading in initial proofreading. During this proofreading, measurement of an internal proofreading through path is performed between the test equipment port 35 and the test equipment port 36.

[0063] As a result of this proofreading, the amendment measured value (T_COR) of an internal proofreading through path is calculated as a ratio of the value (T_RAW) of the non-amended measurement of an internal proofreading through path performed by the network analyzer 21 to the transmission response error coefficient term (TT) by initial proofreading. The non-amended measured value (T_RAW) of an internal proofreading through path and a transmission response error coefficient term (TT) are acquired about the transmission response (T_CUST) of an above-mentioned network analyzer transmission response (T_NA), a fastener, and a cable, the transmission response (T_PAIR) of the port which makes a pair, the transmission response (T_TRAN) of a transmission port, and a proofreading through transmission response (T_CALTHRU). This is expressed by the degree type.

[0064]

[Equation 5]

$$T\_COR = \frac{T\_RAW}{TT} = \frac{T\_NA \times T\_PAIR \times T\_CALTHRU \times T\_TRAN}{T\_NA \times T\_PAIR \times T\_CUST \times T\_TRAN} = \frac{T\_CALTHRU}{T\_CUST}$$

[0065] It is used in order to change into the measured value through the cable and fastener which were connected to the test equipment port where multiport test equipment 22 corresponds in the transmission measuring value in each direction which the ratio (T_CALTHRU/T_CUST) was saved and minded the internal proofreading through path for each set mathematically.

[0066] At step 112, the reflective tracking error coefficient (RT_Refl) about the test equipment port 31 (reflective port) is calculated from the measured value of three reflective criteria behind the test equipment port 31, and the result of initial proofreading. A reflective tracking error coefficient (RT_Refl) is expressed like a degree type about the reflective response (R_NA) of a network analyzer 21, and an above-mentioned reflective port transmission response (T_REFL).

[0067] In a RT_Refl=R_NAx(T_REFL) 2 this equation, 2 (T_REFL) is 2-way loss which returns from the reflective port 28 to the reflective port 28 further in the test equipment port 31.

[0068] At step 113, the reflective tracking error coefficient (RT_Pair) about the test equipment port 35 (port which makes a pair) is calculated from the measured value of three reflective criteria behind the test equipment port 35, and the result of initial proofreading. The reflective tracking error coefficient (RT_Pair) about the test equipment port 35 is expressed like a degree type about the transmission response (T_Pair) of the port which makes a reflective response (R_NA) and the above-mentioned pair of a network analyzer 21.

[0069] In a RT_Pair=R_NAx(T_PAIR) 2 this equation, 2 (T_PAIR) is 2-way loss which returns from the reflective port 28 to the reflective port 28 further in the test equipment port 35.

[0070] At step 114, the ratio of the reflective tracking error coefficient (RT_Refl) about the test equipment port 31 and the reflective tracking error coefficient (RT_Pair) about the test equipment port 35 is simplified like a degree type.

[0071]

[Equation 6]

$$\frac{RT\_Refl}{RT\_Pair}=\frac{R\_NA\times(T\_REFL)^2}{R\_NA\times(T\_PAIR)^2}=\frac{(T\_REFL)^2}{(T\_PAIR)^2}$$

[0072] Since the reflective response (R_NA) of a network analyzer 21 is common in both reflective tracking error coefficient (RT_Refl) of the test equipment port 31, and reflective tracking error coefficient (RT_Pair) of the test equipment port 35, this term is offset.

[0073] step 115 shows to a degree type — as — this — the square root of a ratio is called for.

[0074]

[Equation 7]

$$\sqrt{\frac{RT\_Refl}{RT\_Pair}}=\sqrt{\frac{(T\_REFL)^2}{(T\_PAIR)^2}}=\frac{T\_REFL}{T\_PAIR}$$

[0075] An amendment sign must be chosen when asking for this square root. Since the amount in a square root is just the ratio of two insertion losses, the sign which gives the most fixed group delay (groupdelay) is chosen. In the case of a desirable embodiment, since the design of a test equipment port is almost the same, group delay of a loss ratio must be very close to zero. Group delay is the rate of change of the phase to a frequency. between the frequency measure points with which a sign continues — a ratio — a phase change — as long as — it is chosen so that it may become there is nothing and small. If the ratio of loss through the port which makes a reflective port and a pair is determined, the transmission measuring value acquired through the port which makes this pair is mathematically convertible for the measured value through a reflective port only by carrying out the multiplication of the ratio.

[0076] At step 116, vector error correction in a network analyzer 21 is turned OFF. An internal proofreading through path transmission value (T_SELFCAL) comes to be shown in a degree type.

[0077] At the T_SELFCAL=T_NAxT_PAIRxT_CALTHRUxT_TRAN step 117, the multiplication of the ratio (T_REFL/T_PAIR) calculated at step 114 and the ratio (T_CALTHRU/T_CUST) calculated at step 111 is carried out to an internal proofreading through path transmission value (T_SELFCAL). This is shown in a degree type.

[0078]

[Equation 8]

$$\begin{aligned}&T\_SELFCAL\times\frac{T\_REFL}{T\_PAIR}\times\frac{T\_CUST}{T\_CALTHRU}\\&=T\_NA\times T\_PAIR\times T\_CALTHRU\times T\_TRAN\times\frac{T\_REFL}{T\_PAIR}\times\frac{T\_CUST}{T\_CALTHRU}\\&=T\_NA\times T\_REFL\times T\_CUST\times T\_TRAN\end{aligned}$$

[0079] This is a transmission response error coefficient array about the transmission measuring performed from the test equipment port 31 (reflective port) before the test equipment port 36 (transmission port). This amount is calculated by the above-mentioned automatic proofreading algorithm, without [without it cuts inspected equipment, and] actually performing transmission measuring between the test equipment port 31 and the test equipment port 36.

[0080] The above explanation is what [only] only indicated and explained the typical approach and typical embodiment of this invention. This invention can be carried out with other specific gestalten, without deviating from the thought or essential description so that clearly [this contractor]. Therefore, the indication of this invention means the instantiation and does not restrict the range of this invention specified to a claim.
[0081] The instantiation-embodiment which becomes below from the combination of the various requirements for a configuration of this invention is shown.
[0082] 1. It is an approach for proofreading a network analyzer system (21 22). (a) It is the initial proofreading step which carries out initial proofreading of each inspection port (24, 25, 31-42) of a network analyzer system (21 22). Carry out measurement proofreading using the proofreading criteria located in the base plane arranged to the exterior of a network analyzer system (21 22), and an initial proofreading multiplier is generated. (a. 1) Measure the electronic criteria (80 73-77, 83) in a network analyzer system (21 22), and initial measurement electronic criteria are generated. (a. 2) The initial proofreading step containing each substep of generating initial amendment electronic criteria using said initial proofreading multiplier and said measurement electronic criteria, (a. 3) (b) Are the automatic recalibration step which carries out automatic recalibration, and measure the electronic criteria (80 73-77, 83) in a network analyzer (b. 1) system (21 22), and recalibration measurement electronic criteria are generated. (b. 2) The proofreading approach of the network analyzer system characterized by having an automatic recalibration step containing each substep of generating a re-calculation proofreading multiplier using these recalibration measurement electronic criteria and said initial amendment electronic criteria.

[0083] 2. Approach given in the preceding clause 1 to which electronic criteria (80 73-77, 83) approximate disconnection (74 76), short circuit (75 83), and load (77 80) in said substep (a. 2).
[0084] 3. Approach given in the preceding clause 1 in which said initial proofreading multiplier includes in said substep (a. 1), three reflection error multipliers (DIR), i.e., directivity, source adjustment (SM) and reflective tracking (RT), and one transmission error coefficient (TT), i.e., transmission tracking.
[0085] 4. Approach given in the preceding clause 3 on said substep (a. 1) and relevant to [according to a degree type] correction value (R_COR) about these reflective proofreading criteria in measured value (R_RAW) about reflective proofreading criteria.
[0086]
[Equation 9]

$$R\_RAW = DIR + \frac{R\_COR \times RT}{1-(SM \times R\_COR)}.$$

[0087] 5. Approach given in the preceding clause 3 on said substep (a. 1) and relevant to [according to a degree type] correction value (T_COR) about these transmission proofreading criteria in measured value (T_RAW) about transmission proofreading criteria.
[0088]
[Equation 10]

$$T\_COR = \frac{T\_RAW}{TT \times (1 - SM \times R\_COR)}$$

[0089] 6. Approach given in the preceding clause 3 relevant to correction value (R_COR) in said substep (a. 3), said initial amendment electronic criteria include reflective proofreading criteria, and concerning [the measured value (R_RAW) about these reflective proofreading criteria] reflective proofreading criteria according to degree type.
[0090]
[Equation 11]

$$R\_RAW = DIR + \frac{R\_COR \times RT}{1-(SM \times R\_COR)}.$$

[0091] 7. Approach given in the preceding clause 3 relevant to correction value (T_COR) in said substep (a. 3), said initial amendment electronic criteria include transmission proofreading criteria, and concerning [the measured value (T_RAW) about these transmission proofreading criteria] these transmission proofreading criteria according to degree type.
[0092]
[Equation 12]

$$T\_COR = \frac{T\_RAW}{TT \times (1 - SM \times R\_COR)}$$

[0093] 8. Approach given in the preceding clause 1 said whose inspection port (24, 25, 31-42) of this network analyzer system (21 22) said network analyzer system (21 22) is equipped with network analyzer (21) connected to multiport test equipment (22), and is test equipment port (31-42) of said multiport test equipment (22).
[0094] 9. Said Test Equipment Port (31-42) is Divided so that Pair May be Made. The substep used in order that said substep (a. 1) may generate a transmission coefficient for each set of said test equipment port (31-42), Namely, it asks for the 1st ratio of the transmission response of a fastener (a. 1.1) and a cable, and a proofreading through transmission response. In this case, this proofreading through transmission response is calculated by connecting electrically each set of a test equipment port (31-42) using a proofreading through line. And an approach given in the preceding clause 8 containing the substep that the transmission response of said fastener and a cable is calculated by connecting mutually each set of a test equipment port (31-42) electrically using a fastener and a cable.
[0095] 10. When 2nd Test Equipment Port (36) is Making 3rd Test Equipment Port (35) and Pair, in case Transmission Response Error Coefficient between 1st Test Equipment Port (31) and Said 2nd Test Equipment Port (36) is Calculated It includes that said substep (b. 1) measures the transmission response of the internal proofreading through path transmission value between said 3rd test equipment port (35) and said 2nd test equipment port (36). Said substep (b. 2) to the transmission response of the internal proofreading through path transmission value between the 3rd [said] test equipment port (35) measured at said substep (b. 1), and said 2nd test equipment port (36) The 1st ratio calculated at said substep (a. 1.1) about the internal proofreading through path transmission value between said 3rd test equipment port (35) and said 2nd test equipment port (36), An approach given in the preceding clause 9 including carrying out the multiplication of the 2nd ratio which is a ratio of the transmission response between the reflective input of said multiport test equipment to the transmission response between the reflective input of said multiport test equipment, and said 3rd port, and said 1st port.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the outline of connection of a network analyzer over the inspected equipment using multiport test equipment.
[Drawing 2] It is the block diagram simplifying and showing the radio frequency network analyzer by the conventional technique.
[Drawing 3] It is the explanatory view showing some multiport test equipment by the desirable embodiment of this invention.
[Drawing 4] It is the flow chart which shows the automatic recalibration by the desirable embodiment of this invention.
[Drawing 5] It is the block diagram showing the outline of the proofreading through path in which it is used by the automatic proofreading by the desirable embodiment of this invention.
[Drawing 6] the desirable operative condition of this invention — it is the flow chart which shows separation of the transmission signal path response about two ports where the proofreading through path depended like does not exist, and implementation of automatic proofreading.
[Description of Notations]
21 22 Network analyzer system ()
24 RF Output Port
25 RF Input Port
31-42 Test equipment port
73 Proofreading through Line
74 76 Disconnection
75 83 Short circuit
77-80 Load

[Translation done.]

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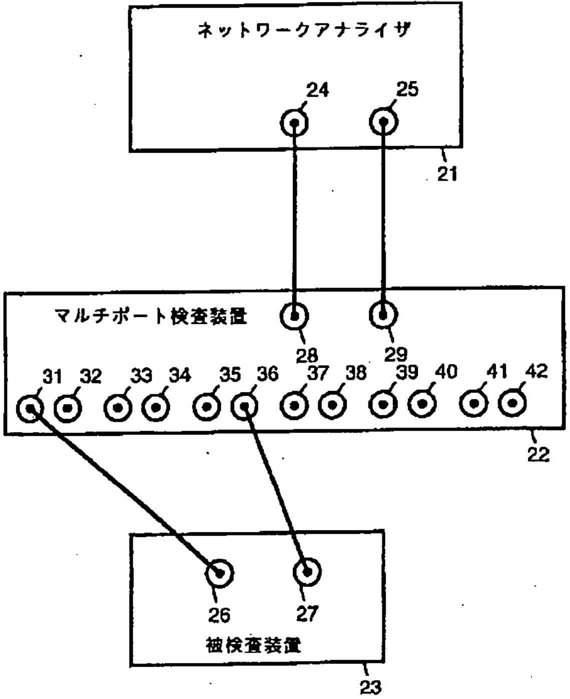
DRAWINGS

[Drawing 1]


ネットワークアナライザ
24
25
21
マルチポート検査装置
28
29
31
32
33
34
35
36
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38
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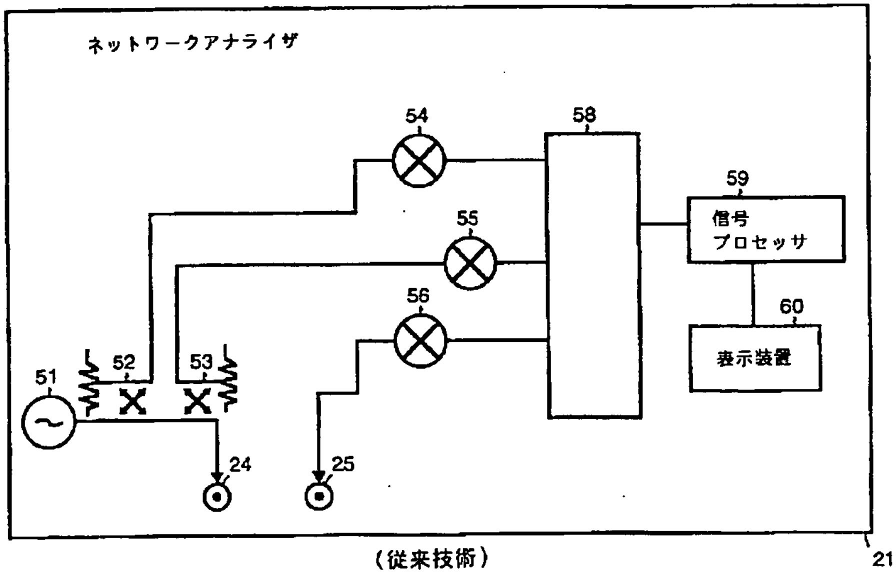
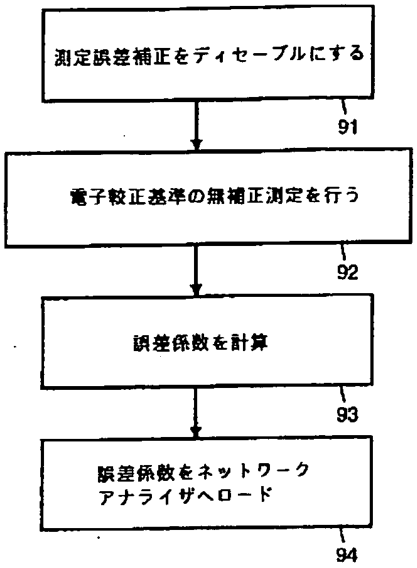
40
41
42
22
26
27
被検査装置
23

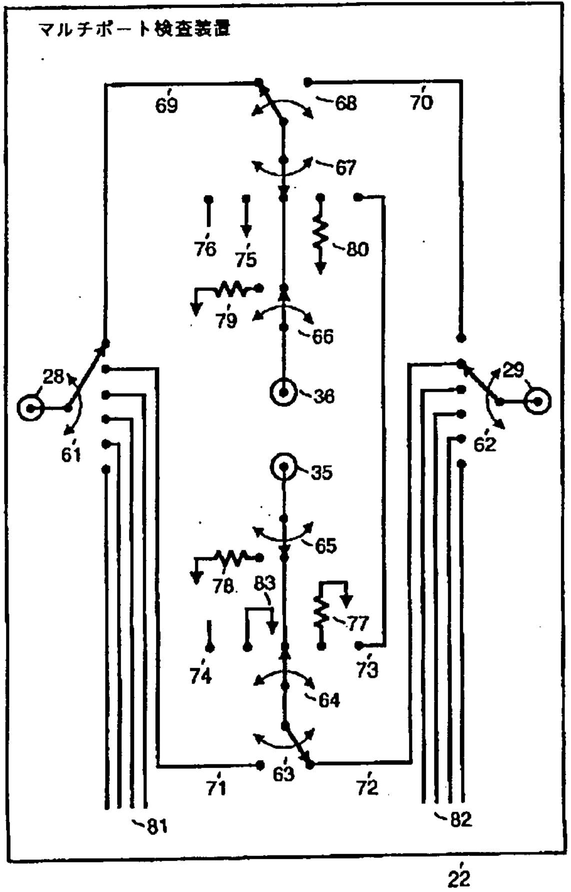
[Drawing 2]


ネットワークアナライザ
54
58
59
信号プロセッサ
55
56
60
表示装置
51
52
53
24
25
（従来技術）
21

[Drawing 4]


測定誤差補正をディセーブルにする
91
電子較正基準の無補正測定を行う
92
誤差係数を計算
93
誤差係数をネットワーク
アナライザへロード
94

[Drawing 3]


マルチポート検査装置
69
68
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80
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28
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36
61
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35
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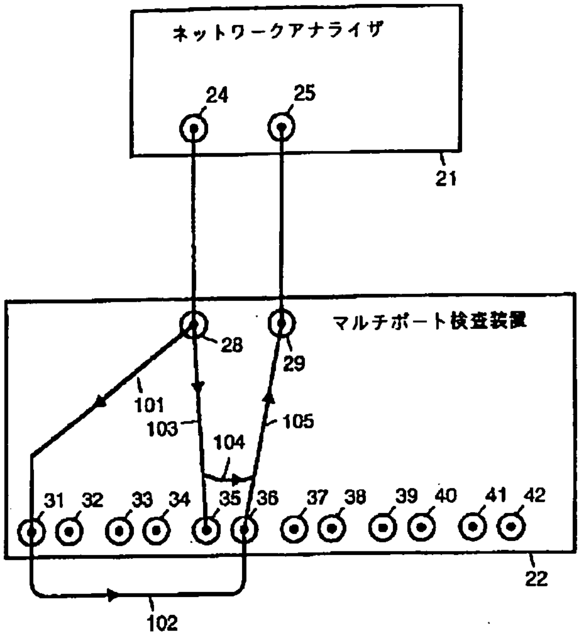
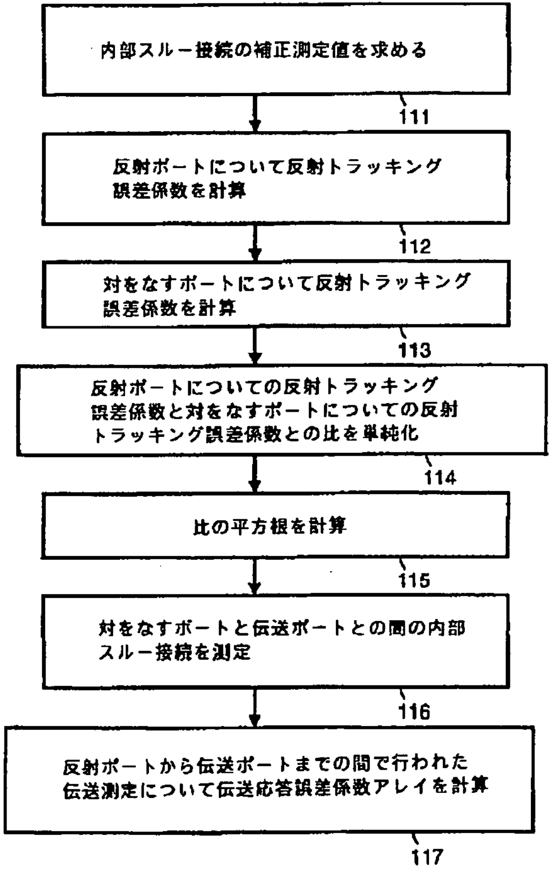
22

[Drawing 5]


ネットワークアナライザ
24
25
21
マルチポート検査装置
28
29
101
103
104
105
31
32
33
34
35
36
37
38
39
40
41
42
22
102

[Drawing 6]


内部スルー接続の補正測定値を求める
111
反射ポートについて反射トラッキング誤差係数を計算
112
対をなすポートについて反射トラッキング誤差係数を計算
113
反射ポートについての反射トラッキング誤差係数と対をなすポートについての反射トラッキング誤差係数との比を単純化
114
比の平方根を計算
115
対をなすポートと伝送ポートとの間の内部スルー接続を測定
116
反射ポートから伝送ポートまでの間で行われた伝送測定について伝送応答誤差係数アレイを計算
117

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CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 1st partition of the 6th section
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[Application number] Japanese Patent Application No. 10-228121
[The 7th edition of International Patent Classification]

G01R 27/28
G01R 35/00

[FI]

G01R 27/28	Z
G01R 35/00	J

[Procedure revision]
[Filing Date] July 27, Heisei 17 (2005. 7.27)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
It is an approach for proofreading a network analyzer system,
(a) It is the step which carries out initial proofreading for every inspection port of said network analyzer system,
(a.1) It is the substep which carries out measurement proofreading using proofreading criteria,
Said proofreading criteria are arranged in the base plane arranged to the exterior of said network analyzer system,
Said measurement proofreading brings about an initial proofreading multiplier.
The substep which consists of things,
(a.2) The substep which measures the electronic criteria in said network analyzer system, and generates initial measurement electronic criteria,
(a.3) The substep which uses said initial proofreading multiplier and said initial measurement electronic criteria, and generates initial amendment electronic criteria
The step which consists of ** being included,
(b) It is the step which carries out automatic recalibration for said every inspection port,
It carries out without using the proofreading criteria arranged in the base plane which said automatic recalibration was carried out after initial proofreading of all the inspection ports in a step (a), and has been arranged to the exterior of said network analyzer system,
Said automatic recalibration,
(b.1) The substep which measures said electronic criteria in said network analyzer system, and generates recalibration measurement electronic criteria,

(b.2) The substep which uses said recalibration measurement electronic criteria and said initial amendment electronic criteria, and generates a re-calculation proofreading multiplier
The step which consists of ** being included
The approach containing **.
[Claim 2]
It is the approach according to claim 1 of consisting of said electronic criteria approximating disconnection, a short circuit, and a load in said substep (a. 2).
[Claim 3]
It sets to said substep (a. 1), and is said initial proofreading multiplier,
Three reflection error multipliers (DIR), i.e., directivity, source adjustment (SM), and reflective tracking (RT),
One transmission error coefficient (TT), i.e., transmission tracking
The approach according to claim 1 of consisting of ** being included.
[Claim 4]
said substep (a. 1) — setting — the measured value (R_RAW) about reflective proofreading criteria — the following formula — namely
R_RAW=DIR+(R_CORxRT)/(1- (SMxR_COR))
The approach according to claim 3 of being alike, and following and consisting of being related with the correction value (R_COR) about these reflective proofreading criteria.

[Translation done.]